

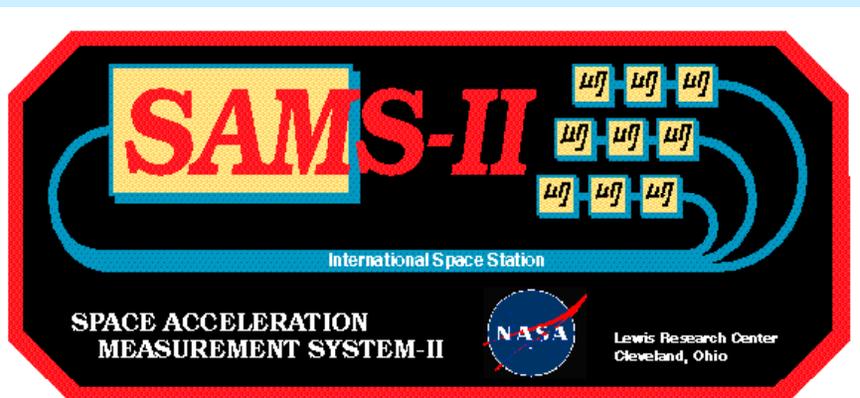
# SAMS-II: Decimation of a Project

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Knowledge Sharing

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# Outline

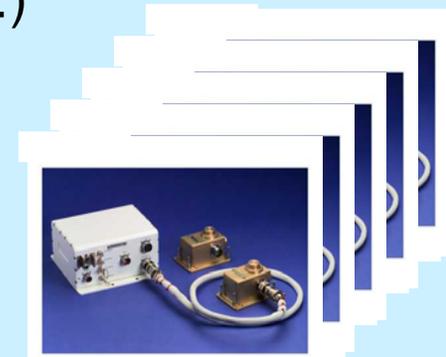
- Project Background
- Realities of being an “ISS project”
- Cuts: The ‘Big One’
- Pain, suffering, and ...survival
- A new awakening
- Conclusion

# Project Background

## Space Acceleration Measurement System-II

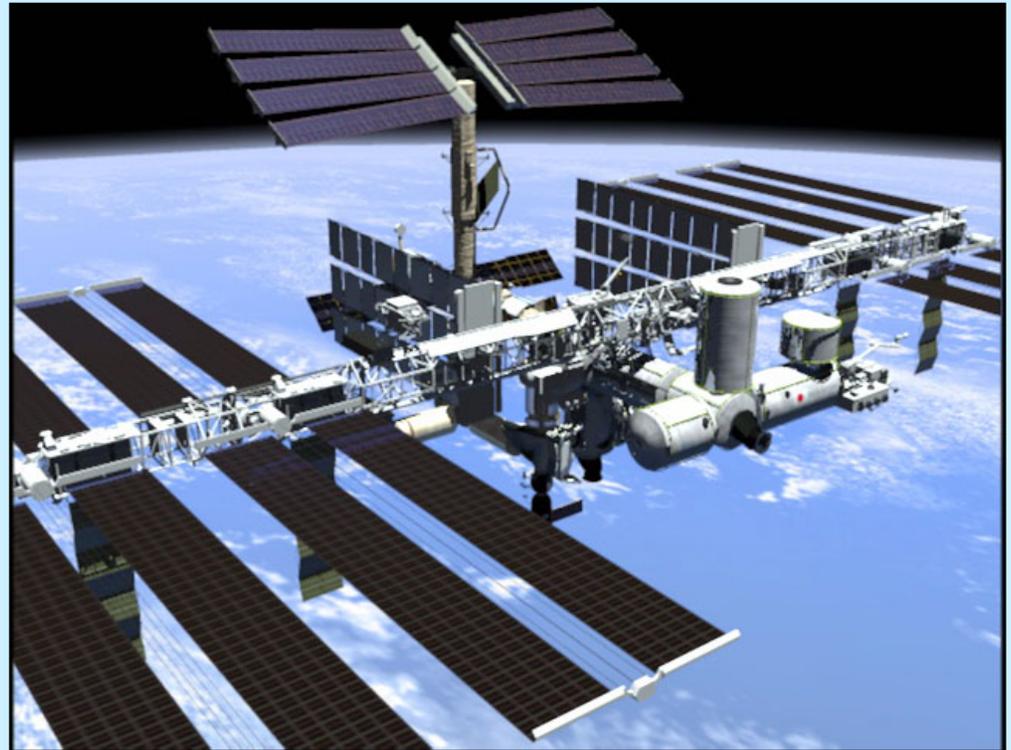
(a 2nd generation system)

- Measures vibratory acceleration disturbances in support of the Microgravity Research Program research experiments (Code UG)
  - Over a dozen STS and Mir missions were supported with SAMS
- Develop a system for 10+ years of operation on a Space Station (Freedom, Alpha, ISS, ...)



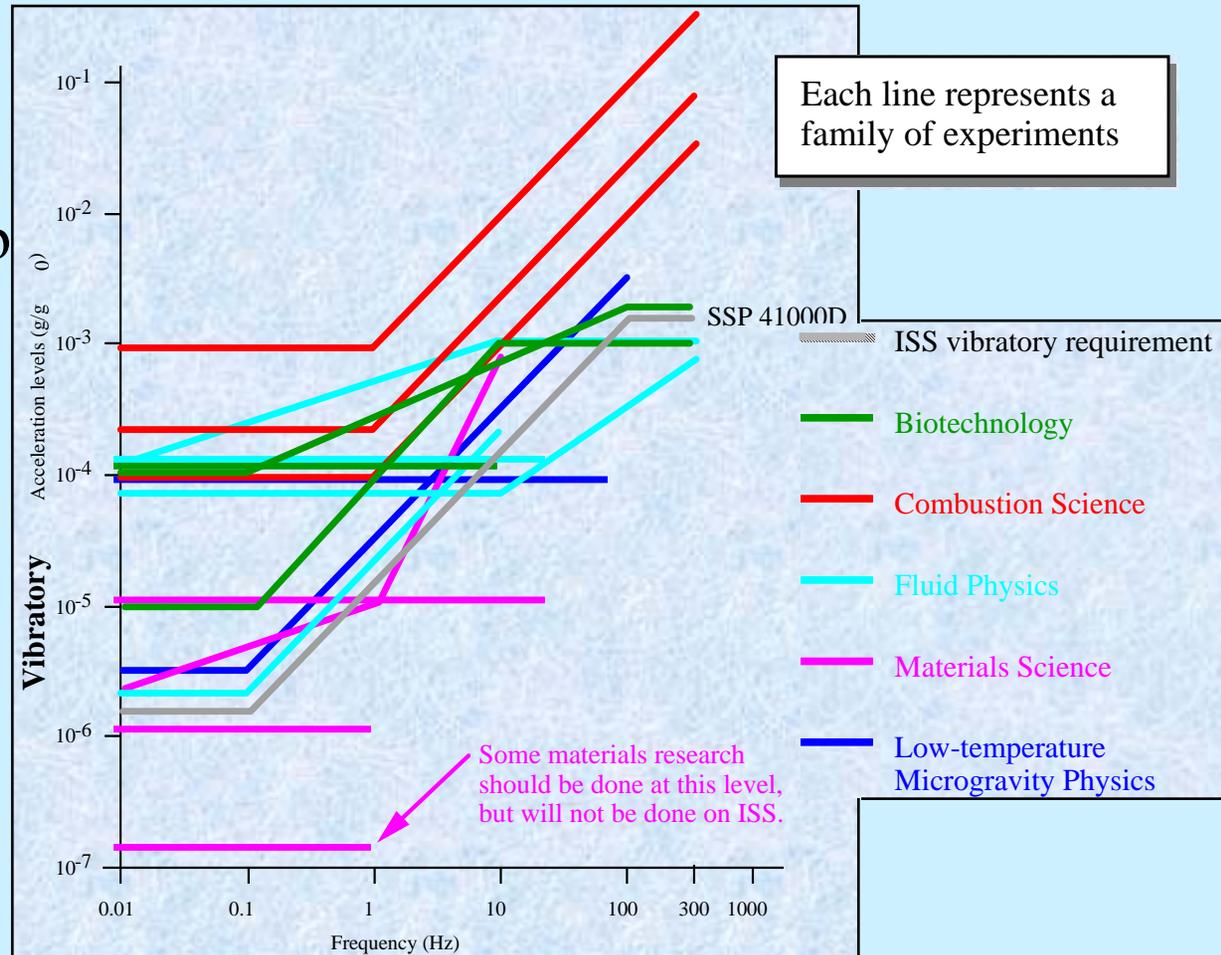
# ISS Research- New Era, New Vehicle

- ISS will provide new opportunities for on-orbit research studies
- Microgravity environment is key component being investigated



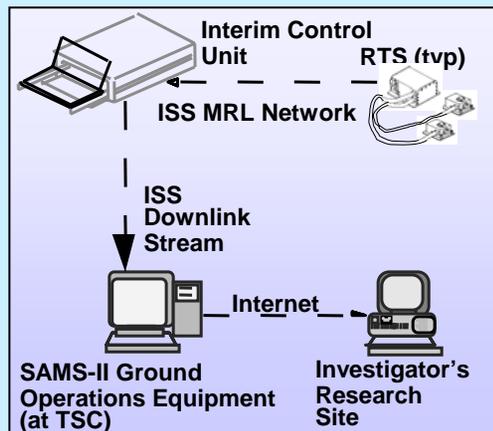
# Desired Research Environment

- Vibratory:
  - Ranges from milli-g to sub  $\mu\text{g}$
- Quasi-Steady:
  - Below  $1 \mu\text{g}$



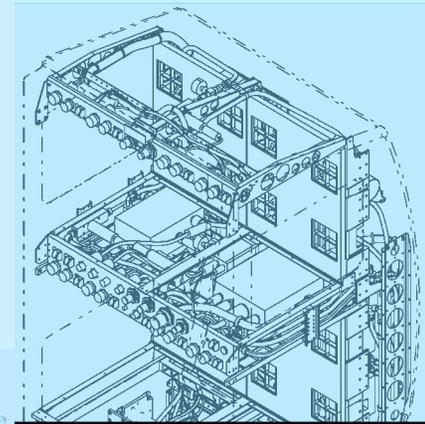
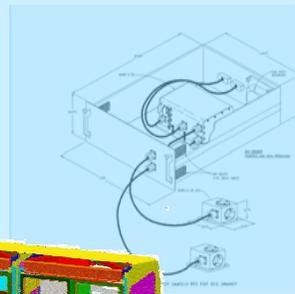
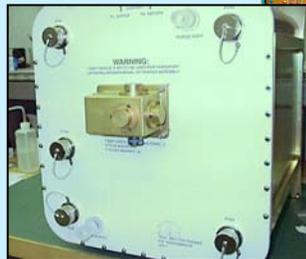
# Measure the Environment for Research

- SAMS-II
  - A vibratory environment measurement system
    - 0.01 Hz to 300 Hz; 1  $\mu$ g to 0.1 g
    - Multiple sensors distributed to payloads
    - Centralized control computer
    - Ground data dissemination
    - Data analysis and trending



# SAMS-II Deployments

- Control Unit
  - NASA EXPRESS Rack
- Remote Triaxial Sensors
  - EXPRESS Rack shelves
  - Drawers
  - Facilities
  - Locker Payloads



## The Customers:

NASA Microgravity  
Science Disciplines

Other research areas (life  
science, space products)

Vehicle dynamicists

Vehicle Maintenance and  
■ Sustaining Engineering

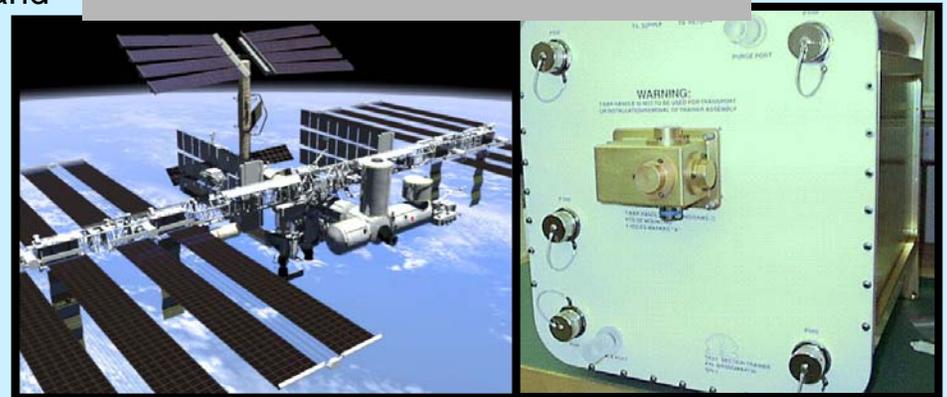
# SAMS for Space Station

## SAMS-II

- SAMS-II is a modular, distributed architecture acceleration measurement and analysis system
  - Control Unit- *data storage and analysis*
  - Remote Triaxial Sensors- *variable frequency ranges*
  - Ground Operations- *PI command and control access*
- Payloads integrate sensors at experiment location
  - Digital sensors, programmable frequency ranges
- General purpose acceleration measurement system
  - Consistent hardware for multiple increments and multiple experiments
  - Facility Racks, EXPRESS Racks capability
  - Provides on-orbit data analysis capability for experiment decision-making and control
- Milestones
  - First flight Electronics unit delivered 5/ 99
  - Flight Control Unit delivered 11/99
  - On-orbit Operations begin 7 / 00



**SAMS-II is a versatile, general purpose acceleration measurement system**



*But I'm getting ahead of myself...*

# All is well... or is it?

- Space Station development
  - A treacherous path
- Payloads are (were) subservient to the vehicle development
  - Requirements
  - Budgets



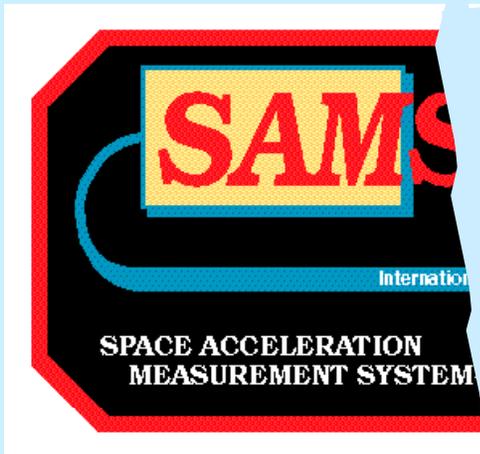
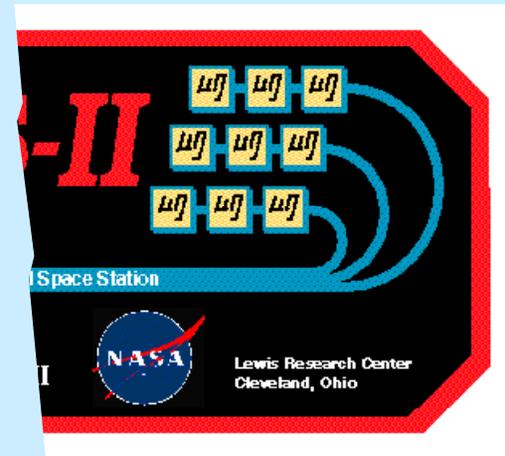
# SAMS-II Redirection Realities

- ISS-budget driven SAMS-II project constraints
  - traffic model (customers and timing)
  - Budget
  - scope... Realities-->
- ISS Problems (\$500M over budget, facilities delay)
  - SAMS-II budget bar chart
- What it means for SAMS-II ...

*(from All-Hands charts on 10/11/96)*

# Decimate the project

NOW



LATER (hopefully)

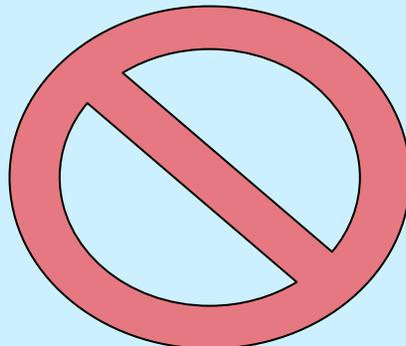
# What it means for SAMS-II ...

- **CLOSE-OUT ALL NON-RTS RELATED WORK**
  - CU redesign efforts to be documented and closed out
  - CU related procurements stopped
  - Q-SICA effort is stopped
  - GOE designs and procurements to be put on hold
  - CU-GSE efforts stopped
  - CU, GOE, CU-GSE Software, RFAs, design put on hold
- **EXCEPTIONS:**
  - Complete the MSS Thermal POC evaluation
  - Complete the Coldplate fabrication capability development study
  - ISSUES: Long lead VME procurement must be assessed
  - Other?

# SAMS-II Redirection Realities (10/96)

## What it means for SAMS-II ...

- CONTINUE RTS WORK
  - Demonstrate the RTS functionality (boot, configure, collect and transmit data) using the Engineering Model hardware RTS
  - Develop and test at qualification levels an RTS system
  - Develop and test flight RTS systems to support user requirements
  - Support flight hardware deliveries to EXPRESS Rack (flight RTS-EEs: 2 at 1/97, 2 at 4/97)
  - Develop the support systems later (CU, GOE) that allows usage of the RTS as provided
    - Will require early creation of key functional elements of CU, GOE to ensure adequate checkout of RTS functions



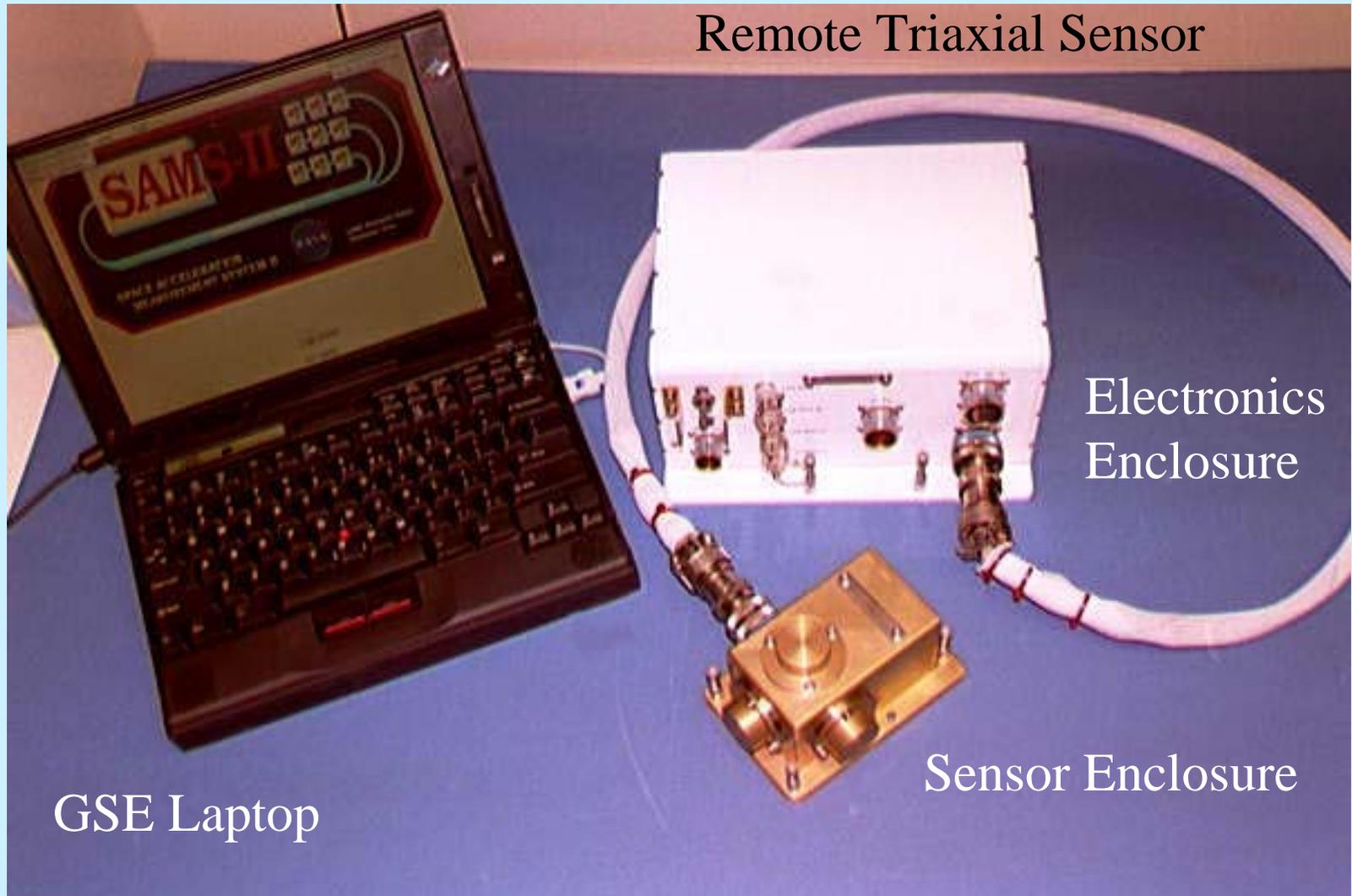
**BUT**

## SAMS-II Redirection Realities (10/96)

# What it means for SAMS-II ...

- OTHER APPROACHES TO BE CONSIDERED BY PROJECT/ BY MANAGEMENT:
  - Eliminate a CU configuration (either Eng. Model or Qualification Unit) to decrease program cost and still maintain a FY01 ship date
  - Redefine SAMS-II operational configuration (eg. a more independently operating RTS capability)
  - Change project operating paradigm (fast-track, different controls and reporting methods, all civil servant implementation team, additional risk acceptance)
- Alternate funding sources- partnering with NASDA, partnering with AMES/Centrifuge project (a sharing of development costs as well as recurring costs for hardware to be provided)
- Open to suggestions on creative ideas to save money, decrease complexity, do more with less, accomplish the same functions with less development costs

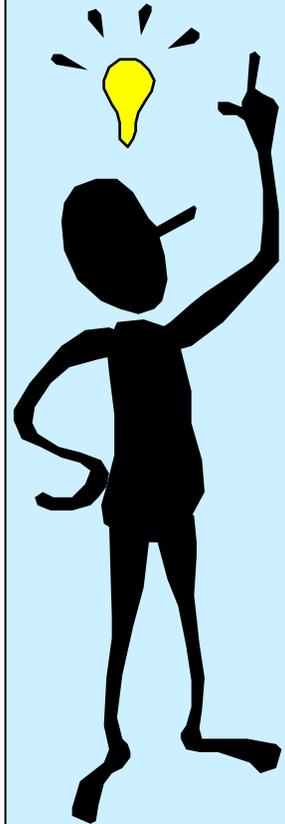
# ... A core system



# Remote Triaxial Sensor

- Implementation Approach
  - Distributed measurement system (multi-user)
  - Minimize sensor head size (RTS-EE + RTS-SE)
  - Maintain performance
- Status
  - CDR 4/97; Phase 1/2 Safety Review 12/97
  - Qual Unit completed testing 6/98
  - Prepare EE Flight Unit #1 to Ship to EXPRESS

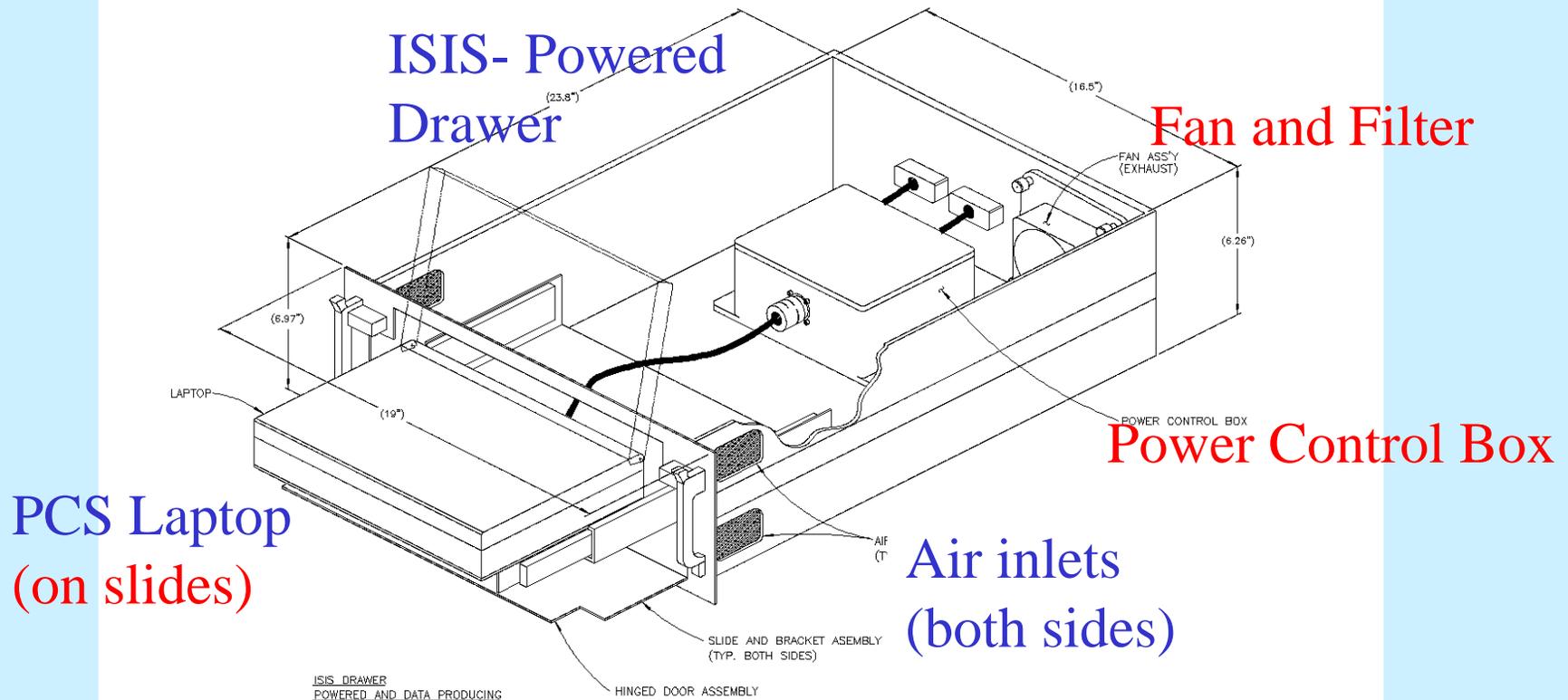
# Remote Triaxial Sensor System



# GSE / Interim Control Unit

- Implementation Approach
  - Rely on existing ISS Laptop (PCS) hardware heritage
  - Deploy SAMS-II-specific software in Laptop for RTS operations
  - House components in a standard ISIS drawer
- Status
  - Prel. Design Review (engineering model)
  - Flight unit shipment planned for 11/99.

# ICU Components

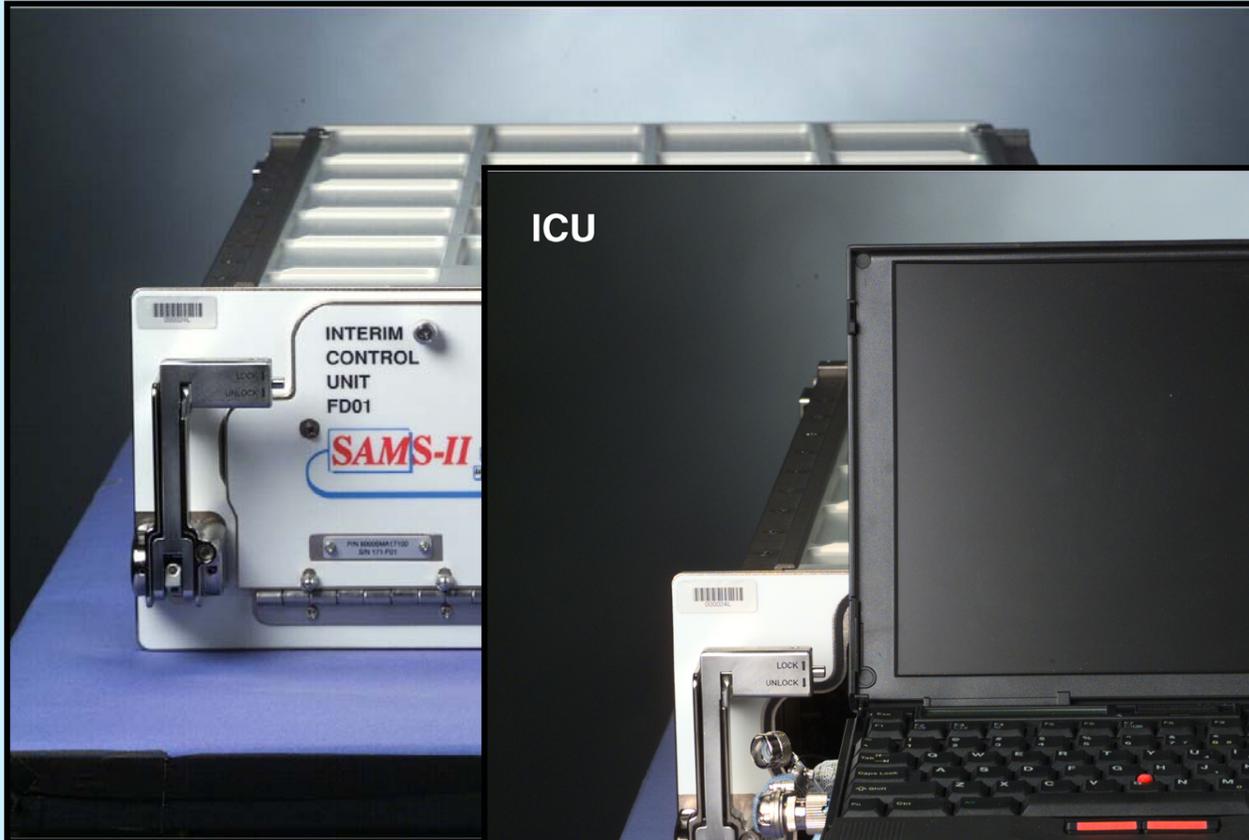


- *custom*  
- *standard*

# ICU Components

- ISIS Drawer (*ISS standard*)
- ThinkPad 760XD Laptop (*ISS standard*)
- Power Control Box (PCB)
- Fans (Drawer & PCB)
- Circuit Breakers
- Designed with Military and Industrial Electronics for Reliability

# Interim Control Unit



# Remote Triaxial Sensor System



Flight Unit #1

# More with Less...

- Upon approval of the approach SAMS-II was solicited to provide support to:
  - First Fluid Physics Experiment (EXP-PCS)
  - A vehicle Risk Mitigation Experiment (ARIS-ICE),
  - The Microgravity Science Glovebox, and
  - General vehicle characterization...
  - And others...

# Acceleration Measurement Program

## ISS Traffic Model

### Current Scope (SAMS-II)



#### **BASELINE**

		UF 1 4/00	UF 2 8/00	UF 3 2/02	UF 5 9/02	1E 10/02	17A 11/02	HTV2 2/03	UF 6 8/03	UF 7 10/03	Future
<b>Interim Control Unit</b>											
<b>Control Unit</b>											
<b>Remote Triaxial Sensors</b>											
<b>EXPRESS Rack</b>	EE										
	SE	(PCS)	(TBD)			(TBD)	(TBD)				
<b>Fluids &amp; Combustion Facility</b>	EE										
	SE										
<b>Material Science Research Facility</b>	EE										
	SE										(7/04)
<b>Glovebox (MSG)</b>	EE										
	SE										
<b>Biotechnology Facility (BTF)</b>	EE										
	SE										
<b>Low Temperature Microgravity Physics Facility (LTMPF)</b>	EE										
	SE										

# Acceleration Measurement Program

## ISS Traffic Model

### Added Scope (SAMS-II)



		UF 1 4/00	UF 2 8/00	UF 3 2/02	UF 5 9/02	1E 10/02	17A 11/02	HTV2 2/03	UF 6 8/03	UF 7 10/03	Future
<b>OPPORTUNITIES</b>											
MAMS											
<b>Remote Triaxial Sensors</b>											
ARIS RME	EE	(2) 									
	SE	 (3)									
EXPRESS Rack Ground Simulator	EE										
	SE	 (2/99)									
Multi Phase Flow and Transport Facility (MPFTF)	EE										
	SE										 (2005)
NASDA	EE			(4) 							
	SE			 (5) (8-10/01)							

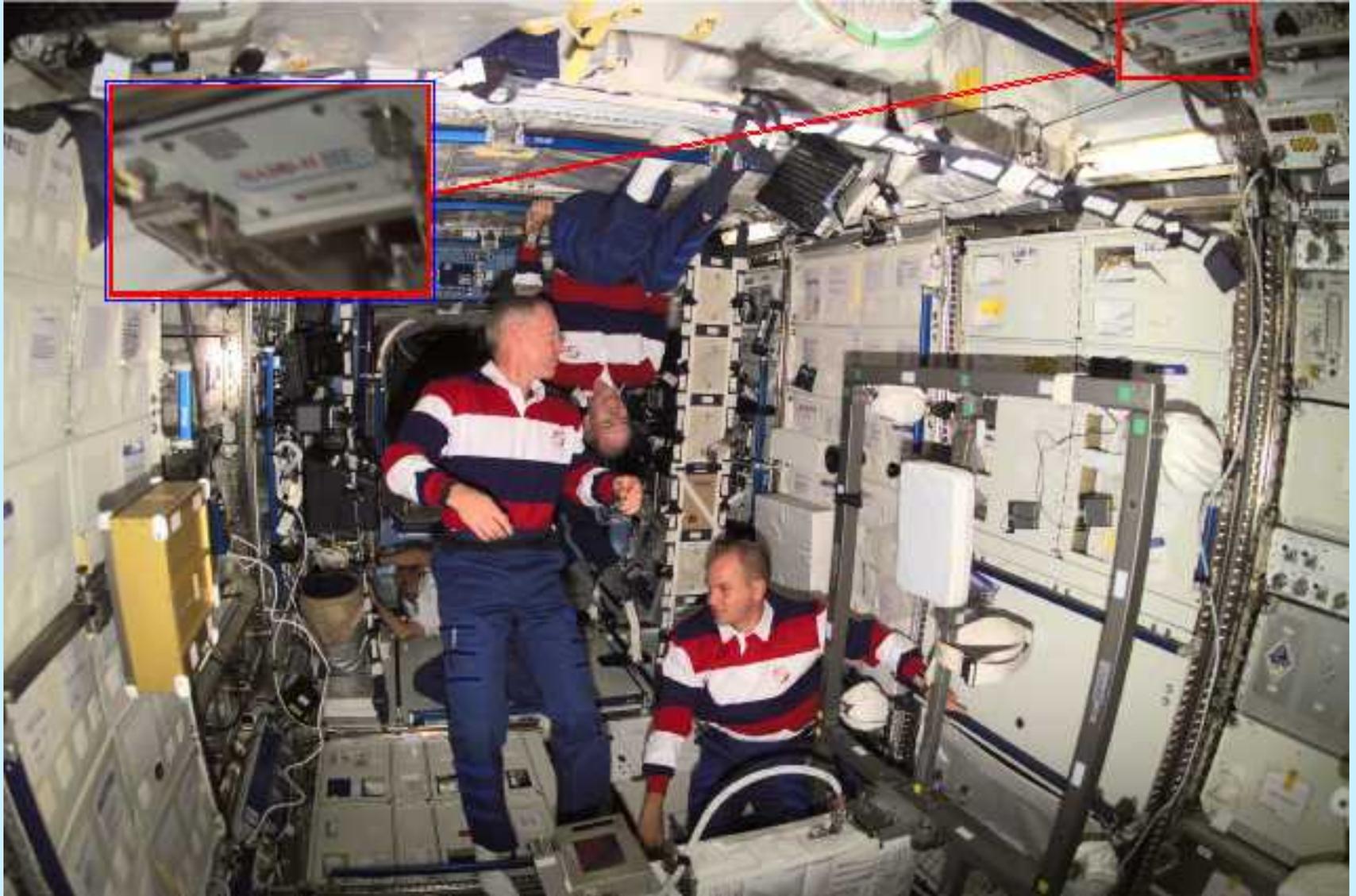
# And we did it!

- SAMS-II system elements were successfully launched aboard STS-100 (ISS flight 6A), April, 2001.
- First data was acquired and downlinked on June 5, 2001
- SAMS-II has accumulated over 16,000 hours of on-orbit operational time and data.



ICU (on orbit,  
in EXPRESS 4)

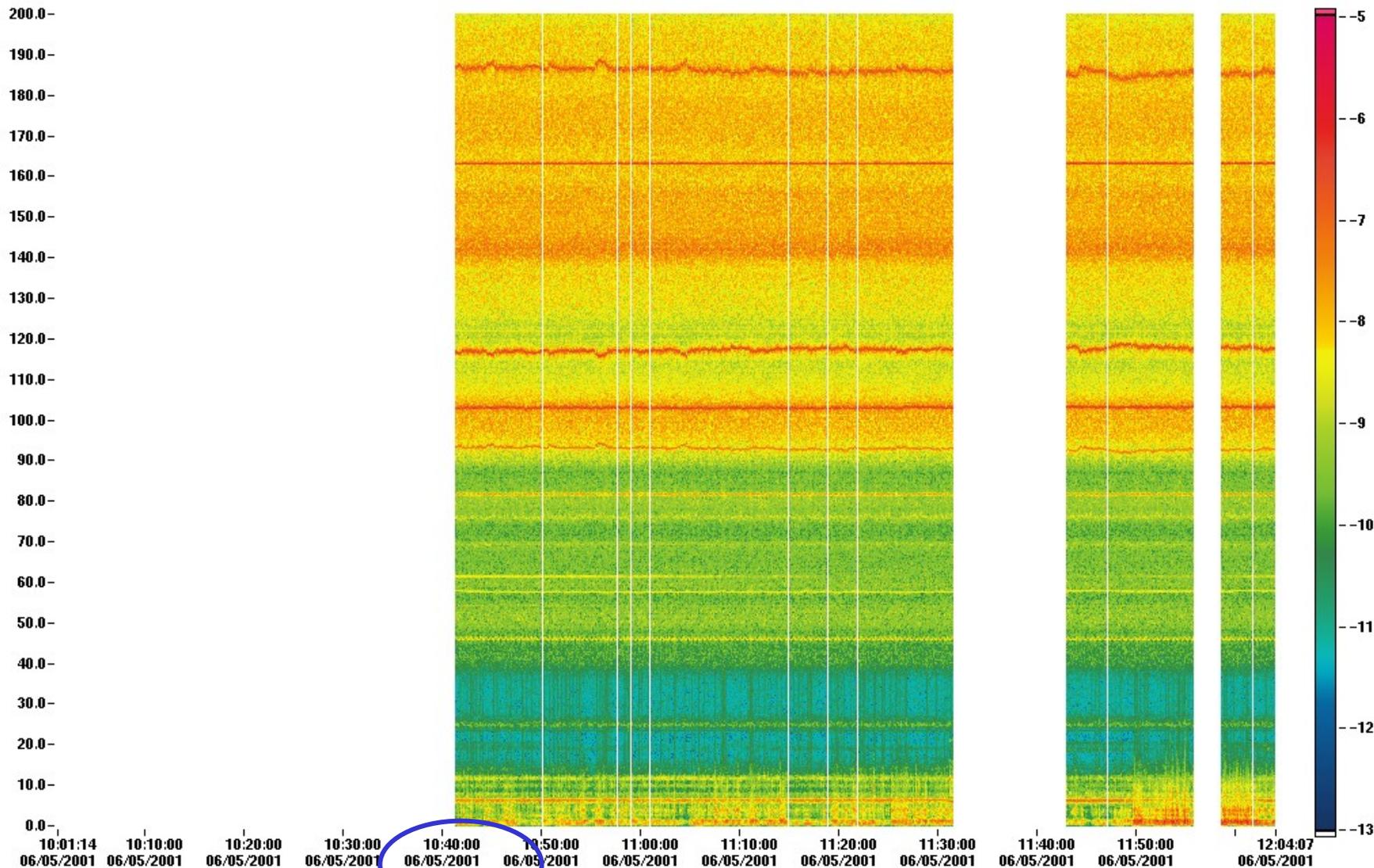
# RTS-Drawer (on orbit)



No new data available Tue Jun 5 13:38:33 2001

Coordinate System: 121f06 Sensor ID: 121-f06 Axis: Sum of XYZ Windowing Method: Hanning Sensor ID: 121-f06 Axis: Sum of XYZ Windowing Method: Hanning

Max Frequency(Hz): 200 df: 0.1221 Samples per sec: 500.0 PSD Points: 4096 Overlap in %: 0 Temporal Resolution in sec: 8.192



First SAMS-II Data (June 5, 2001)

# Key Points

- Communicating bad news can be done.
  - Projects and people are resilient.
- Focus on what is still viable.
  - Teams just need a little positive reinforcement to remind them that the glass usually half full.
- Remember that change usually has a positive element, too.
- SAMS-II was destined to be a success.
  - Success comes in many forms.

# Epilogue

- And as is typical of success stories, I was promoted.
  - So, on to my next challenge...

# Combustion ■ Science Program

*(my next challenge)*

- Science
  - Fundamental research
- Flight Projects
  - To conduct the investigator's science

# Combustion Science on ISS

*An Annihilation of the Program Content*

(~2001)

2 Facilities, 15 PIs,  
3 partner investigations,  
Future research capability

Principal Investigator (PI)  
Droplet Combustion  
Experiments



Combustion Payloads



Multi-User

**But that's another story.**

Combustion Experiment in  
Fluids and Combustion Facility  
Combustion Chamber



Multi-User Solid Fuel  
Combustion Apparatus

- SIBAL
- FIST
- TIGER-3D
- REEFS
- ATHINA
- STF-Pello



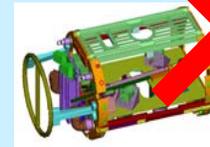
Cool Flames  
Combustion Investigation



Multi-User Gaseous  
Fuel Combustion Apparatus

- V-Flame
- Flame Design
- S-Flames
- PUFF

Commercial/ International  
Partner Apparatus



- Water Mist
- Galytic Comb
- Hi-Pressure

Combustion  
Experiment in the  
Microgravity  
Science Glovebox



- Smoke
- SPHER
- SALSA

ISS US Lab  
Module



# Backup Information

## SAMS-II: Decimation of a Project

*(how to save a project)*

*(and build a team)*

*(and surpass expectations)*

*(and garner new customers)*

# SAMS-II History

- SAMS-II initiated in 1991
- Requirements gathered from UG disciplines
- Architecture defined CU, multiple RTS
  - System Hardware PDR held 11/95
- CU delayed (10/96), ICU concept developed
- RTS proceeding towards multiple deliveries
  - RTS CDR held 4/97; status of RFAs
- Operations to begin at 6A (4/00) [rev Rev D]